

**FINAL REPORT
JANUARY 2006**

REPORT NO. 06-01



**40" X 48" COLLAPSIBLE QUICK-CRATE CONTAINER,
MIL-STD-1660 TESTS,
"DESIGN CRITERIA FOR AMMUNITION UNIT LOADS"**

Prepared for:

Distribution Unlimited

League Manufacturing
608 Furman Road
P.O. Box 3626
Greenville, SC 29608-3626



**DEFENSE AMMUNITION CENTER
VALIDATION ENGINEERING DIVISION
MCALESTER, OKLAHOMA 74501-9053**

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CRATE CONTAINER, MIL-STD-1660 TESTS,
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ABSTRACT

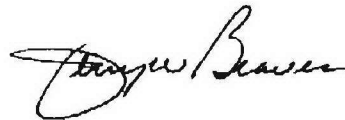
The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SJMAC-DEV) conducted MIL-STD-1660 Tests, "Design Criteria for Ammunition Unit Loads" on the 40" x 48" Quick Crate Container manufactured by League Manufacturing, from Greenville, SC. Two (2) containers were tested with a load of 4,055 lbs. each. The tests accomplished on the test units were the stacking, vibration, drop, incline impact, forklift handling, and disassembly tests. The containers passed all requirements with no significant problems encountered. As a result of the performance of the container, the 40" x 48" Quick Crate Container manufactured by League Manufacturing is suitable for United States Army use in such applications as retrograde repacking operations.

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**40" x 48" COLLAPSIBLE QUICK CRATE CONTAINER,
MIL-STD-1660 TESTS,
"DESIGN CRITERIA FOR AMMUNITION UNIT LOADS"**

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PART 1 – INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SJMAC-DEV) conducted MIL-STD-1660 Tests, "Design Criteria for Ammunition Unit Loads" on the 40" x 48" Quick Crate Container manufactured by League Manufacturing, Greenville, SC. Two (2) containers were tested with a load of 4,055 lbs. each. The tests accomplished on the test units were the stacking, vibration, drop, incline impact, forklift handling, and disassembly tests. The unitization procedures were provided by DAC, Transportation Engineering Division (SJMAC-DET).

B. AUTHORITY. This test was conducted IAW mission responsibilities delegated by the U.S. Army Joint Munitions Command (JMC), Rock Island, IL. Reference is made to the following:

1. AR 740-1, 15 June 2001, Storage and Supply Activity Operation
2. OSC-R, 10-23, Mission and Major Functions of U.S. Army Defense Ammunition Center (DAC) 21 Nov 2000.

C. OBJECTIVE. The objective of the tests was to determine if the 40" X 48" Quick Crate Container met the MIL-STD-1660 test requirements prior to the acceptance of the unitization procedures by the U.S. Army.

D. CONCLUSION. The containers passed all tested requirements with no significant problems encountered. As a result of the performance of the container, the 40" x 48" Quick Crate Container manufactured by League Manufacturing is suitable for United States Army use in such applications as retrograde repacking operations.

PART 2 - ATTENDEES

DATE PERFORMED:

Test Unit #1- December 14, 2005

Test Unit #2- December 15, 2005

Test Unit #3- Not Tested

ATTENDEE

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PART 3 - TEST PROCEDURES

MIL-STD-1660 TEST. The test procedures outlined in this section from were extracted from the MIL-STD-1660. The tests are conducted on ammunition pallet units or unit loads and are summarized as follows:

A. STACKING TEST. The test unit will be tested to simulate a stack of identical items stacked 16 feet high, for a period of one hour. This stacking load will be simulated by subjecting the specimen to a compression weight equal to an equivalent 16-foot stacking height. Photo 1 below shows an example of a unit load in the compression tester.

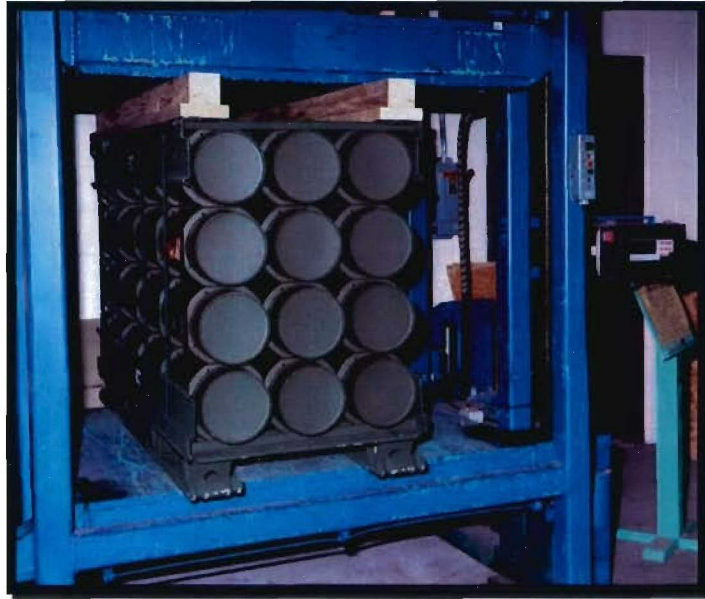


Photo 1. Example of Stacking Test.
(2.75-inch Hydra 70, PA151 Rocket Pallet in the Stacking Test.)

B. REPETITIVE SHOCK TEST. The repetitive shock test is conducted IAW Method 5019, Federal Standard 101. The test procedure is as follows: The test unit will be placed on (not fastened to) the platform. With the test unit in one position, the platform will be vibrated at ½-inch amplitude

(1-inch double amplitude) starting at a frequency of approximately 3 cycles-per-second. The frequency will be steadily increased until the specimen leaves the platform. The resonant frequency is achieved when a 1/16-inch-thick feeler gage momentarily slides freely between every point on the specimen in contact with the platform at some instance during the cycle. Midway into the testing period, the specimen will be rotated 90 degrees, and the test continued for the duration. Unless failure occurs, the total time of vibration will be three hours. Photo 2 shows an example of the repetitive shock test.



**Photo 2. Example of the Repetitive Shock Test.
(MSTF Low)**

C. EDGEWISE ROTATIONAL DROP TEST. This test is conducted using the procedures of Method 5008, Federal Standard 101. The procedure for the edgewise-rotational drop test is as follows: The test unit will be placed on its skids with one end of the pallet supported on a beam 6 inches high. The height of the beam will be increased as necessary to ensure that there is no support for the skids between the ends of the specimen when the dropping takes place, but should not be high enough to cause the specimen to slide on the supports when the dropped end is raised for the drop. The unsupported end of the specimen is then raised and allowed to fall freely to the concrete, pavement, or similar

unyielding surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection will conform to the following tabulation:

GROSS WEIGHT (WITHIN RANGE LIMITS) (Pounds)	DIMENSIONS OF ANY EDGE, HEIGHT OR WIDTH (WITHIN RANGE LIMITS) (Inches)	HEIGHT OF DROPS ON EDGES	
		Level A (Inches)	Level B (Inches)
150-250	60-66	36	27
250-400	66-72	32	24
400-600	72-80	28	21
600-1,000	80-95	24	18
1,000-1,500	95-114	20	16
1,500-2,000	114-144	17	14
2,000-3,000	Above 145- No limited	15	12
Above – 3,000		12	9

Figure 1.



Photo 3. Example of Edgewise Rotational Drop Test
(MSTF Low)

D. INCLINE-IMPACT TEST. This test is conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the incline-impact test is as follows: The test unit will be placed on the carriage with the surface or edge to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage will be brought to a predetermined position on the incline and released. If it were desired to concentrate the impact on any particular position on the container, a 4- x 4-inch timber may be attached to the bumper in the desired position before the test. The carriage will not strike any part of the timber. The position of the specimen on the carriage and the sequence in which surfaces and edges are subjected to impacts may be at the option of the testing activity and dependent upon the objective of the test. When the test is to determine satisfactory requirements for a container or pack, and, unless otherwise specified, the specimen will be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at the time of the impact will be 7 feet-per-second. Photo 4 shows an example of this test.



**Photo 4. Example of the Incline-Impact Test.
(2.75-Inch, Hydra 70, PA151 Rocket Pallet on incline-impact tester.)**

E. SLING COMPATIBILITY TEST. The test unit utilizing special design or non-standard pallets will be lifted, swung, lowered and otherwise handled as necessary, using slings of the types normally used for handling the unit loads under consideration. Slings will be easily attached and removed. Danger of slippage or disengagement when load is suspended will be cause for rejection of the specimen.

F. FORKLIFTING TESTS. The test unit will be lifted clear of the ground by a forklift from the end of the test unit and transported on the forks in the level or back-tilt position. The forklift will pass over the Optional Rough Handling Course For Forklift Trucks as outlined in MIL-STD-1660. The course will consist of parallel pairs of 1-inch boards spaced 54 inches apart and will be laid flat wise on the pavement across the path of the forklift. One pair will be laid at an angle of approximately 60 degrees to the path so that the left wheel strikes first. Another pair will be laid securely across the path of the forklift so that the wheels strike simultaneously. Another pair will be laid at an angle of approximately 75 degrees to the path so that the right wheel strikes first. The test unit will be transported over the Optional Rough Handling Course. The test unit shall be observed for deflection and damage. The test unit will be rotated 90 degrees and the test unit lifted from the side and the above steps repeated.

PART 4 - TEST EQUIPMENT

A. COMPRESSION TESTER.

- | | |
|-----------------------|----------------------|
| 1. Manufacturer: | Ormond Manufacturing |
| 2. Platform: | 60- x 60-inches |
| 3. Compression Limit: | 50,000 pounds |
| 4. Tension Limit: | 50,000 pounds |

B. TRANSPORTATION SIMULATOR.

- | | |
|------------------|---------------------|
| 1. Manufacturer: | Gaynes Laboratory |
| 2. Capacity: | 6,000-pound payload |
| 3. Displacement: | 1/2-inch amplitude |
| 4. Speed: | 50 to 400 RPM |
| 5. Platform: | 5- x 8-foot |

C. INCLINED PLANE.

- | | |
|------------------|--------------------|
| 1. Manufacturer: | Conbur Incline |
| 2. Type: | Impact Tester |
| 3. Grade: | 10 percent incline |
| 4. Length: | 12-foot |

PART 5 - TEST RESULTS

5.1. TEST UNIT DATA. The test units were inertly loaded to the specified design weight using M548 Cans loaded with inert material. The test units were prepared using the unitization procedures specified in Part 6 - Drawings. Special care was taken to ensure that each M548 ammunition can had the proper amount of weight in order to achieve a realistic pallet center of gravity (CG). Once properly prepared, Test Units #1 and #2 were tested using MIL-STD-1660 requirements. Test Unit #3 was not tested.

TEST UNIT #1

40" x 48" COLLAPSIBLE QUICK CRATE CONTAINER

Test Date: 14 December 2005 (MIL-STD-1660)
Gross Weight: 4,055 pounds
Length: 40 inches
Width: 48 inches
Height: 50-1/2 inches
Mfgr: League Manufacturing, Greenville, SC

TEST UNIT #2

40" x 48" COLLAPSIBLE QUICK CRATE CONTAINER

Test Date: 15 December 2005 (MIL-STD-1660)
Gross Weight: 4,055 pounds
Length: 40 inches
Width: 48 inches
Height: 50-1/2 inches
Mfgr: League Manufacturing, Greenville, SC

A. MIL-STD-1660 TEST RESULTS TEST UNIT #1:

1. **STACKING TEST**. The test unit was compressed with a load force of **12,165** pounds for 60 minutes on 14 December 2005. No damage was noted as a result of this test. See Photo 5 of the test unit in the compression unit.



Photo 5. Test Unit in the Stacking Test.

2. **REPETITIVE SHOCK TEST**. The test unit was vibrated 90 minutes at **222** RPM in the longitudinal orientation and 90 minutes at **185** RPM in the lateral orientation on 14 December 2005. No damage was noted as a result of this test. Photo 6 shows the test unit on the vibration platform.



Photo 6. Test Unit During Repetitive Shock Testing.

3. EDGEWISE-ROTATIONAL DROP TEST. The test unit was edgewise rotationally dropped from a height of 12 inches on both longitudinal sides and both lateral sides. No significant damage was noted as a result of this test; however, the test unit sustained minor damage to the bottom skids and the top deck during drop testing. The damage was deemed minor because it would not interfere with the container safely continuing on with its intended mission. The minor damage that occurred is common to this type of container with the 4,000-lb. load capacity. Photo 7 shows the test unit during the edgewise drop test. Photo 8 shows the minor damage sustained during the drop tests.



Photo 7. Edgewise Drop Test on the Test Unit.



Photo 8. Minor Damage Sustained During Drop Test.

4. INCLINE-IMPACT TEST. The test unit was impact tested on both longitudinal sides and both lateral sides. No significant damage was noted as a result of this test. See Photo 9 for the specimen during the lateral incline-impact test.



Photo 9. Incline-Impact Testing of the Test Unit.

5. **SLING COMPATIBILITY TEST.** N/A

6. **FORKLIFTING TEST.** The test unit was lifted clear of the ground by a forklift from both longitudinal sides and both lateral sides and transported on the forks. Photo 10 shows the test unit during the Forklifting Test. No damage was noted as a result of this test.



Photo 10. Test Unit During the Forklifting Test

7. **DISASSEMBLY TEST.** Inspection revealed no damage.

8. **CONCLUSION.** No major problems were encountered during the completion of the required testing. The test unit passed the requirements of the MIL-STD-1660.

B. MIL-STD-1660 TEST RESULTS TEST UNIT#2:

1. **STACKING TEST.** The test unit was compressed with a load force of **12,165** pounds for 60 minutes on 15 December 2005. No damage was noted as a result of this test.

2. **REPETITIVE SHOCK TEST.** The test unit was vibrated 90 minutes at **222** RPM in the longitudinal orientation and 90 minutes at **185** RPM in the lateral orientation on 15 December 2005. No damage was noted as a result of this test.

3. **EDGEWISE-ROTATIONAL DROP TEST.** The test unit was edgewise rotationally dropped from a height of 12 inches on both longitudinal sides and both lateral sides. Identical minor damage was sustained as was noted for Test Unit #1 during the drop test for Test Unit #2.

4. **INCLINE-IMPACT TEST.** The test unit was impact tested on both longitudinal sides and both lateral sides. No significant damage was noted as a result of this test.

5. **SLING COMPATIBILITY TEST.** N/A

6. **FORKLIFTING TEST.** The test unit was lifted clear of the ground by a forklift from both longitudinal sides and both lateral sides and transported on the forks. No damage was noted as a result of this test.

7. **DISASSEMBLY TEST.** Inspection revealed no damage

8. **CONCLUSION.** No major problems were encountered during the completion of the required testing. The test unit passed the requirements of the MIL-STD-1660.

PART 6 – DRAWINGS

The following drawing represents the load configuration that was subjected to the test criteria.

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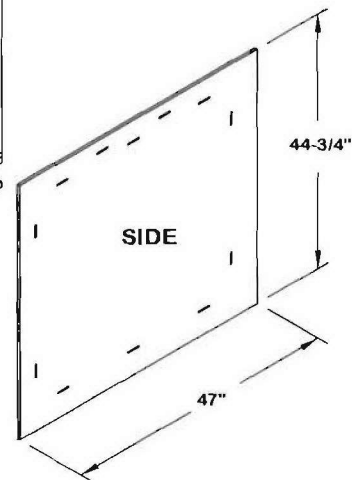
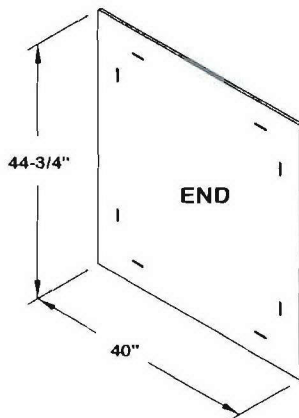
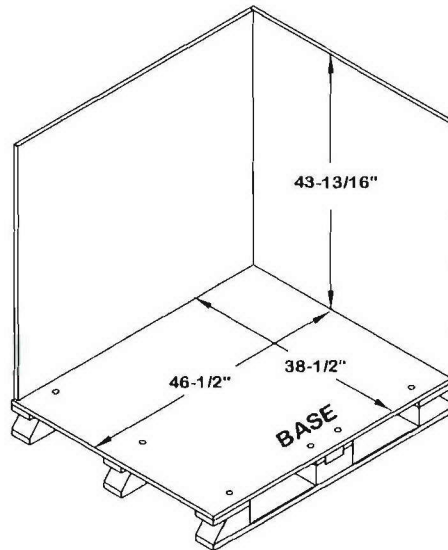
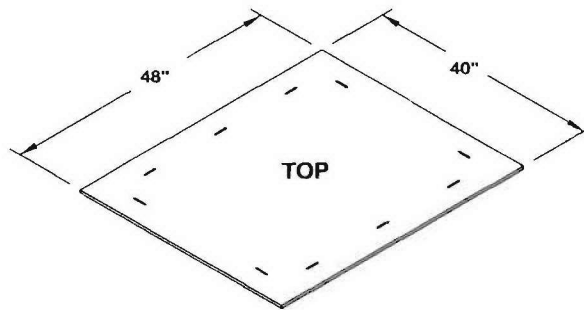
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MIL-STD 1660 TESTING OF THE QUICK CRATE CONTAINER

**THIS THREE PAGE DOCUMENT DEPICTS PROCEDURES FOR UNITIZING
M548 CONTAINERS IN THE QUICK CRATE CONTAINERS.**

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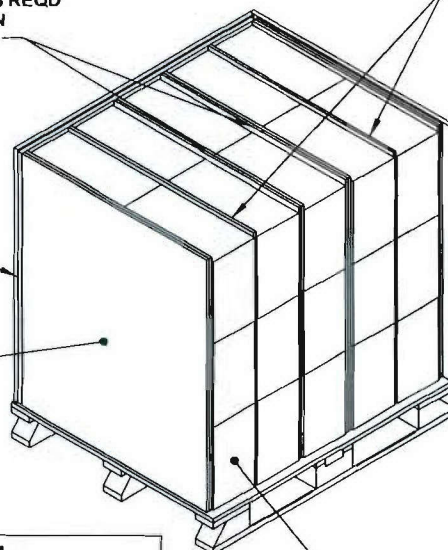


CENTER FILL
36-3/4" X
43-1/2" X 1/2"
FIBERBOARD
2 SHEETS REQD
BETWEEN
LAYERS.

SIDE FILL
46-1/2" X
43-1/2" X 1/2"
FIBERBOARD
1 SHEET REQD
PER SIDE.

END FILL
36-3/4" X
43-1/2" X 1/2"
FIBERBOARD
2 SHEET REQD
PER END.

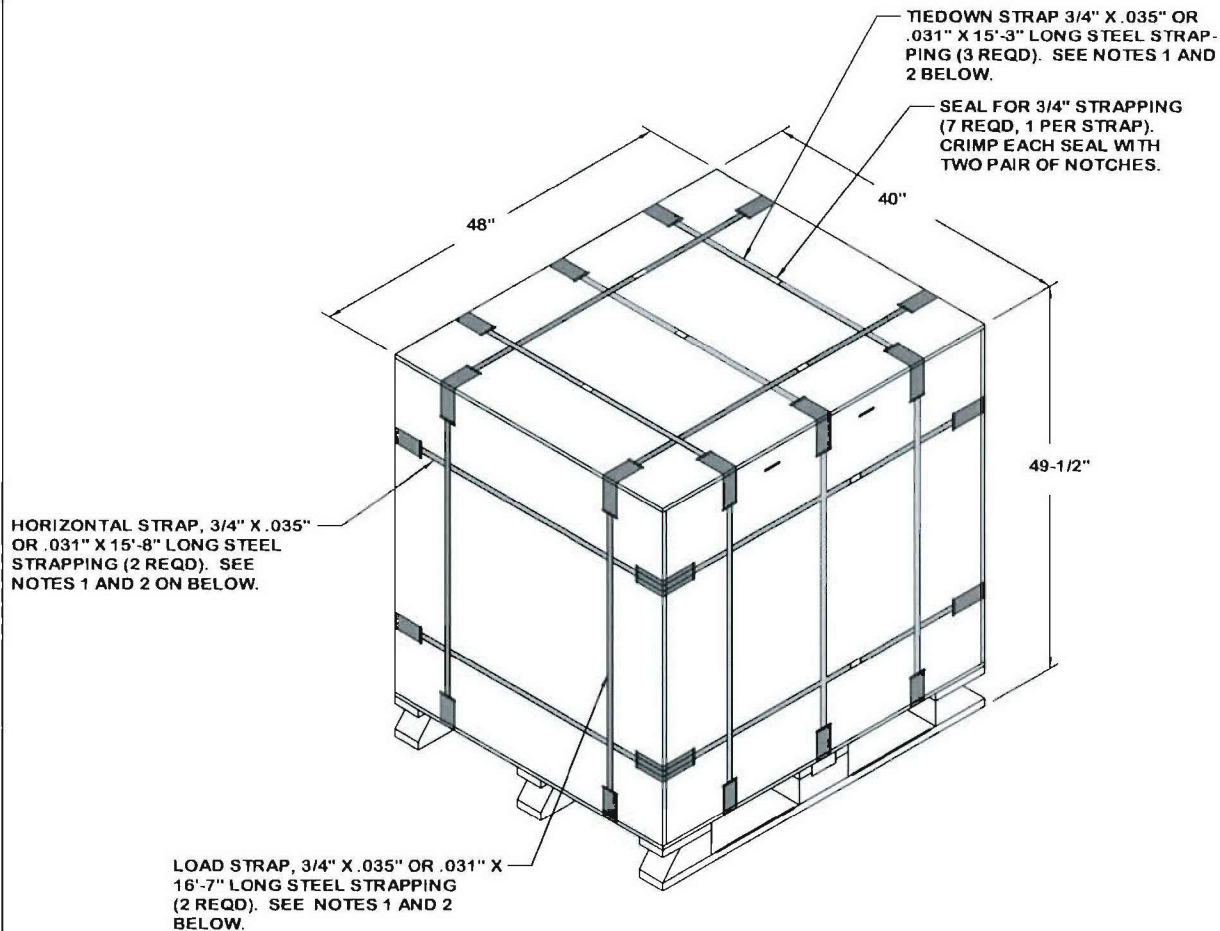
INTERMEDIATE FILL
36-3/4" X
43-1/2" X 1/2"
FIBERBOARD
1 SHEET REQD
BETWEEN
LAYERS.



M548 METAL BOX
30 REQD.

BILL OF MATERIAL

M548 BOXES AT 126 LB EACH	- -	30 REQD	- - -	3780 LBS
FIBERBOARD, 1/2"	- - - - -	139.11' REQD	- - -	12 LBS



PALLET UNIT
QUICK CRATE
UNIT DATA

30 M548 BOXES AT 126 LBS EACH	3,780 LBS
DUNNAGE	22 LBS
PALLET BOX	260 LBS
<hr/>	
TOTAL WEIGHT	4,062 LBS
CUBE	55.0 CU FT

NOTES:

1. WHEN APPLYING ANY STRAP, CARE MUST BE EXERCISED TO ASSURE THAT THE END OF THE STRAP ON THE UNDERSIDE OF THE JOINT EXTENDS AT LEAST 6" BEYOND THE SEAL. THE EXTRA MINIMUM LENGTH OF STRAP IS REQUIRED TO PERMIT SUBSEQUENT TIGHTENING OF LOOSENED STRAPPING.
2. INSTALL EACH HORIZONTAL, LOAD, AND TIEDOWN STRAP TO BE LOCATED AS SHOWN. HORIZONTAL STRAPS MUST BE TENSIONED AND SEALED PRIOR TO THE APPLICATION OF TIEDOWN AND LOAD STRAPS. LOAD STRAPS MUST BE TENSIONED AND SEALED AFTER THE HORIZONTAL STRAPS AND PRIOR TO THE TIEDOWN STRAPS.

BILL OF MATERIAL

PALLET BOX, QUICK CRATE	1 REQD	260 LBS
STEEL STRAPPING, 3/4"	110.25' REQD	9.84 LBS
SEAL FOR 3/4" STRAPPING	7 REQD	NIL
FIBERBOARD, 1/2"	139.11' REQD	11.61 LBS